Effects of Cognitive Activity on Eye-movement Features

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Introduction

The cognitive workload is a measure of the amount of mental effort exerted on a given task, a composite of working memory, attentional load, and executive function [1]. Cognitive workload, in human factors studies, usually refers to the concept of imposing demands on humans' limited mental resources. The high workload has long been recognized as an essential source of performance errors during human-computer interaction.

Recently, certain researchers had used eye-movement to measure the cognitive demands [2, 3]. However, the results obtained by many researchers are not always the same and the results have limited implications and applications [4, 5].

Therefore, this study aimed to assess the cognitive workload state using two types of measurements, comprising traditional measurement and complexity measurement, and compare the results. The traditional measurement is the real eye movement values for the eye movement features, comprising the eye saccades, blinks, pupil dilations, fixation positions, and duration. The complexity measurement is the traditional features that was analyzed using multiscale entropy (MSE).

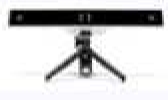
Methodology

Participant

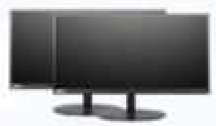
Six master students in a private university in Taiwan. They were three males and three females aged in 20-30 years old and did not have any vision impairment.

Apparatus

PC with Intel® Core ™ i7-6700



GP3 HD 150Hz Eye Tracker and its built software



Experiment and Controlling Screen

Experimental Variables

- **Independent Variables**
  a. Type→ graphic and text explanation
  b. Level→ easy and hard level
- **Dependent Variables**
  The eye movement features generated by the eye tracker

Feature Name		Description
FPOGX	Fixation	[illegible]
FPOGY		[illegible]
FPOGD		[illegible]
LPCX	Pupil Coordinates	[illegible]
LPCY		[illegible]
RPCX		[illegible]
RPCY		[illegible]
LPD	Pupil Diameters	[illegible]
RPD		[illegible]
LPMM		[illegible]
RPMM		[illegible]
BKPMIN	Number of Blinks	[illegible]

Setting and Procedure

Each participant was asked to sit in front of the screen as is shown in figure below. The participant performed easy and hard problems for 5 and 10 minutes, respectively. The order of performing the four experimental combinations was designed using the Latin Square method. A five-minute break was given between two experimental combinations. The participants' eye-movement was recorded using a desktop eye tracker.

Analysis Method

➤**Traditional measurement**: used ANOVA to get the mean value of eye-movement features.

➤**Complexity measurement**:
1. Used the EMD method to separate signals into a set of intrinsic mode functions (IMFs).
2. Used MSE method to calculate the entropy values of these IMFs as complexity features.
3. Used ANOVA to get mean value of complexity eye-movement features

Results

The analysis results in the critical eye movement features that significantly (P-value <0.005) affected by the different cognitive workload level.

1. The results from traditional eye-movement features

Variables	
Type	**Level**
LPMM, RPMM	BKPMIN

2. The results from complexity eye-movement features

Variables	
Type	**Level**
-	L/RPD, LPMM, LPCX/Y, RPCX/Y, FPOGX/Y

Conclusion

➤Mathematical problems as cognitive workload tasks had a significant effect on the eye-movement features produced such as pupils, blinks, and fixations.

➤ Complexity features are more sensitive than the traditional eye-movement features: 9 features (traditional: 3 features)

➤Further research can test these critical features to build the AI model to predict the human cognitive states on doing computer activities.

References

References can be found through this link: http://bit.ly/Reference_EyePoster